GDAŃSK UNIVERSITY OF TECHNOLOGY

THE NEW POLISH CATALOGUE OF TYPICAL FLEXIBLE AND SEMI-RIGID PAVEMENTS

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29th INTERNATIONAL BALTIC ROAD CONFERENCE 27-30 AUGUST 2017 TALLINN

POLITECHNIKA GDAŃSKA

OUTLINE

- Introduction
- Terminology and structure
- Traffic
- Materials
- Subgrade
- Lower layers and improved subgrade
- Calculations of upper layers
- Results – new structures
- Conclusions

INTRODUCTION

- Financed by Polish Highway Agency (GDDKiA)
- 2009-2012 (36 months)
- 12 workpackages
- Reviewed by 50 road specialists and institutions

- Recommended for use in 2014
- Implemented by law in 2015

Free access to catalogue

https://www.gddkia.gov.pl/userfiles/articles/z/zarzadzenia-generalnego-dyrektor_13901/zarzadzenie%2031%20zalacznik.pdf

PREVIOUS CATALOGUES

Polish Catalogues for Flexible and semi-rigid structures

118 pages with examples

2014 r. **1997 r.** **1983 r.** **1977 r.**

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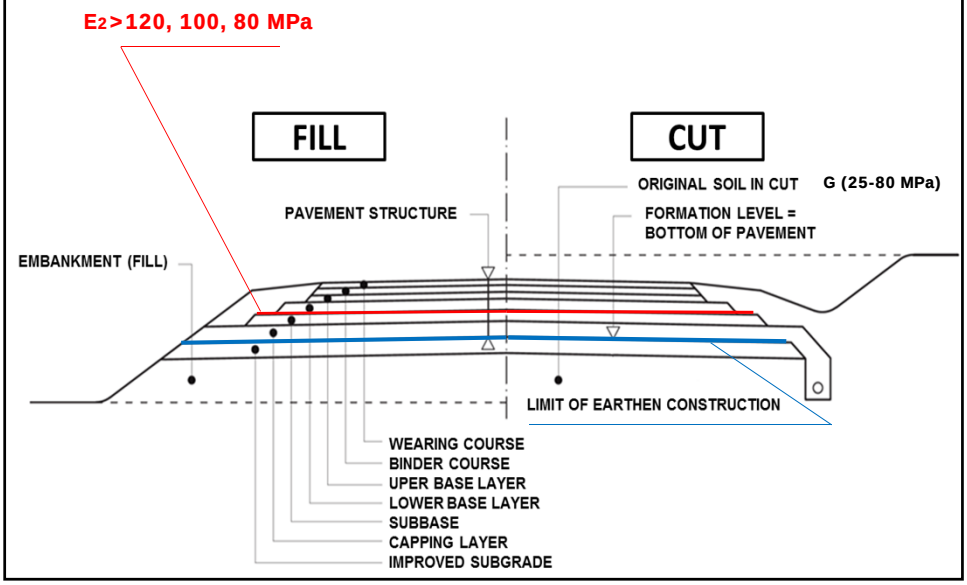
PAVEMENT STRUCTURE



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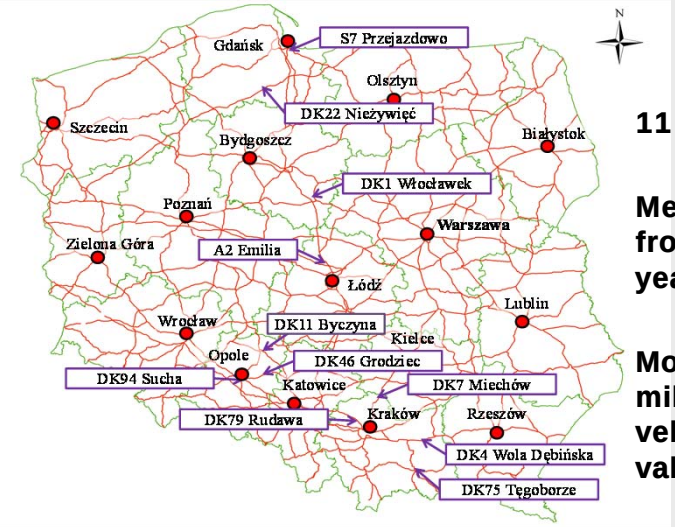
TRAFFIC

- Design life period
  - 30-years for motorways and expressways
  - 20-years for other roads (national, district, local)
- Two classes of allowed load
  - 115 kN – motorways, expressways and national
  - 115 kN or 100 kN other roads – temporarily period
- Equivalent Single Axle Load – 100 kN
  - New equivalency factor: HGV without and with trailer, coaches&buses
  - Factors accounting: lane width and number, longitudinal gradient
- 7 categories of traffic (KR1-30,000 to KR7-90,000,000 ESAL)

TRAFFIC (2)



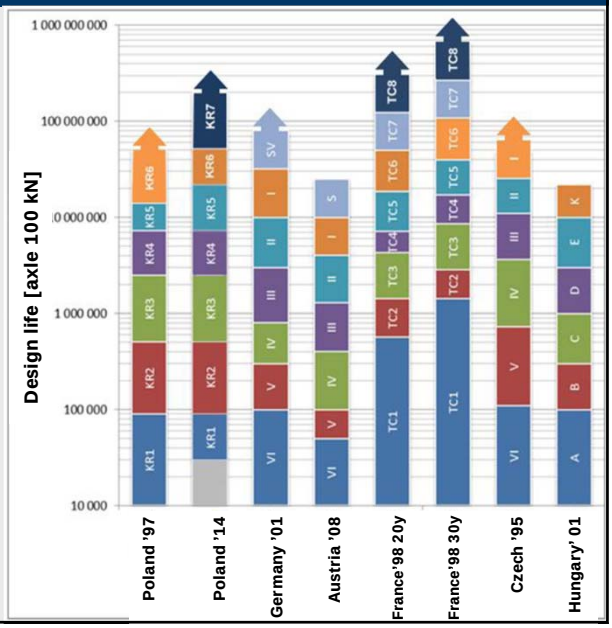
11 WIM stations

Measurement period from 1 to 6 whole years

More than 12 millions heavy vehicles after data validation

TRAFFIC (3)

Design life:
-all standardized to 100 kN
-20 or 30 years



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MATERIALS

- **Wearing course:** SMA, AC, PA, BBTM
- **Upper base and binder course:** AC (HMAC not included)
- **Lower base course:**
  - Unbound aggregate mixture (UM): $C_{90/3}$, $C_{50/30}$, C_{NR}, CBR>80 or 60%
  - Hydraulically bound mixture (HBM): $C_{8/10}$, $C_{5/6}$, $C_{3/4}$
  - Hydraulically treated soil (HTS): $C_{3/4}$, $C_{1,5/2}$
  - Cold recycling mixture (cement +bitumen emulsion or foam bitumen)

MATERIALS (2)

- **Subbase:** UM $C_{NR,}$ CBR>60%, HBM and HTS $C_{5/6}$, $C_{3/4}$, $C_{1,5/2}$
- **Capping layer** – frost layer or drainage layer: HBM or HTS $C_{1,5/2}$, UM CBR>35 or 25% or in case of drainage layer UM, soil n.s.f.h.
- **Improved subgrade:** UM CBR>20%, soil n.s.f.h., HTS $C_{0,4/0,5}$

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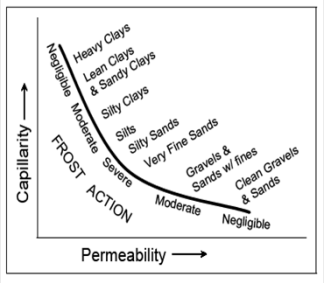
SUBGRADE

- 4 subgrade classes-groups: G1, G2, G3 i G4
- Subgrade classified by bearing capacity: CBR → in situ static plate modulus E_2 and by frost susceptibility

Lp.	Subgrade group Gi	CBR after 4 days soaking [%]	Static plate modulus E_2 [MPa]
1	*2*	*3*	*4*
1.	G1	CBR ≥ 10	$E_2 \geq 80$
2.	G2	5 ≤ CBR < 10	$50 \leq E_2 < 80$
3.	G3	3 ≤ CBR < 5	$35 \leq E_2 < 50$
4.	G4	2 ≤ CBR < 3	$25 \leq E_2 < 35$



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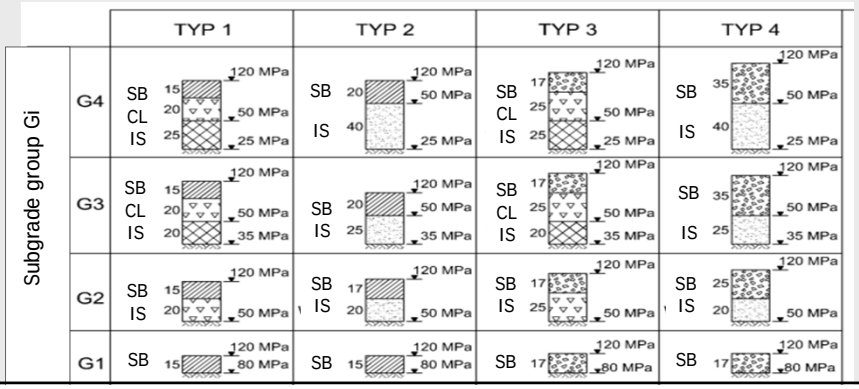
LOWER PAVEMENT LAYERS AND IMPROVED SUBGRADE

- 3 levels of bearing capacity on top of lower pavement layers structure:
  - E_2 = 80 MPa – KR1 i KR2
  - E_2 = 100 MPa – KR3, KR4
  - E_2 = 120 MPa – KR5, KR6 and KR7

SB - subbase
CL – capping layer
IS – improved subgrade



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CALCULATION

1. Mechanistic criteria (IA'81, AASHTO'04, F'94, Shell'77)
2. Empirical method - AASHTO '93
3. Catalogues
   - Austria '08
   - Germany '01
   - Poland '97
   - UK method '06
   - France '98

CALCULATION (2)

- AASHTO 2004 – main criterium
  - FC=5, 10, 15 i 20%
- IA, Shell – only for comparison
- F – only for HMAC (finally not included)
- University of Illinois (Dempsey) – for semi-rigid
- PCA – for semi-rigid

CALCULATION ASSUMPTIONS

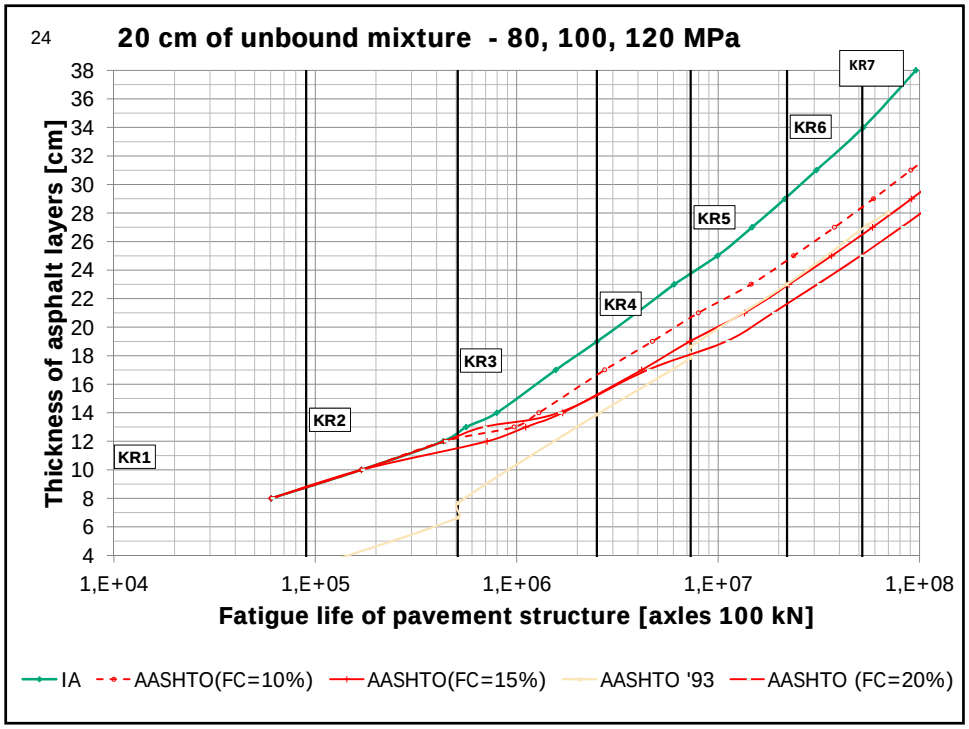
1. Mechanistic calculation of upper pavement layers for support level of 120, 100 and 80 MPa, depending on the traffic class KR
   - solutions for lower pavement layers and improved subgrade were calculated before
2. Accepted results
   - according to AASHTO 2004
3. Comparison of accepted results with other catalogues
4. Implementation of technological tolerances for asphalt layers (+1 cm for asphalt packet)

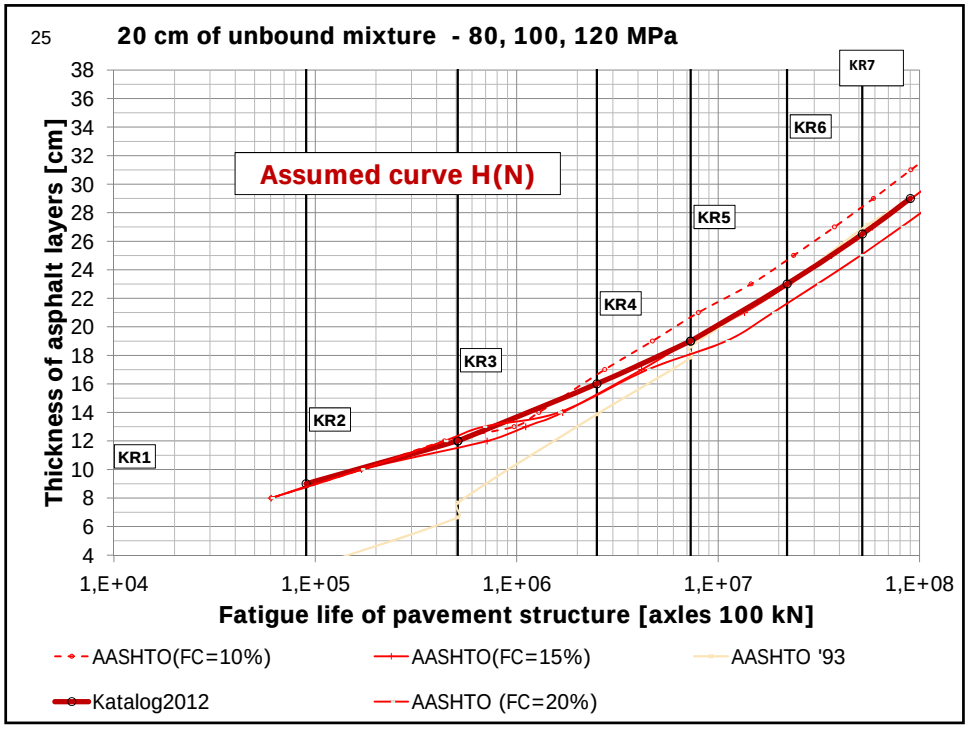
CALCULATION ASSUMPTIONS (2)

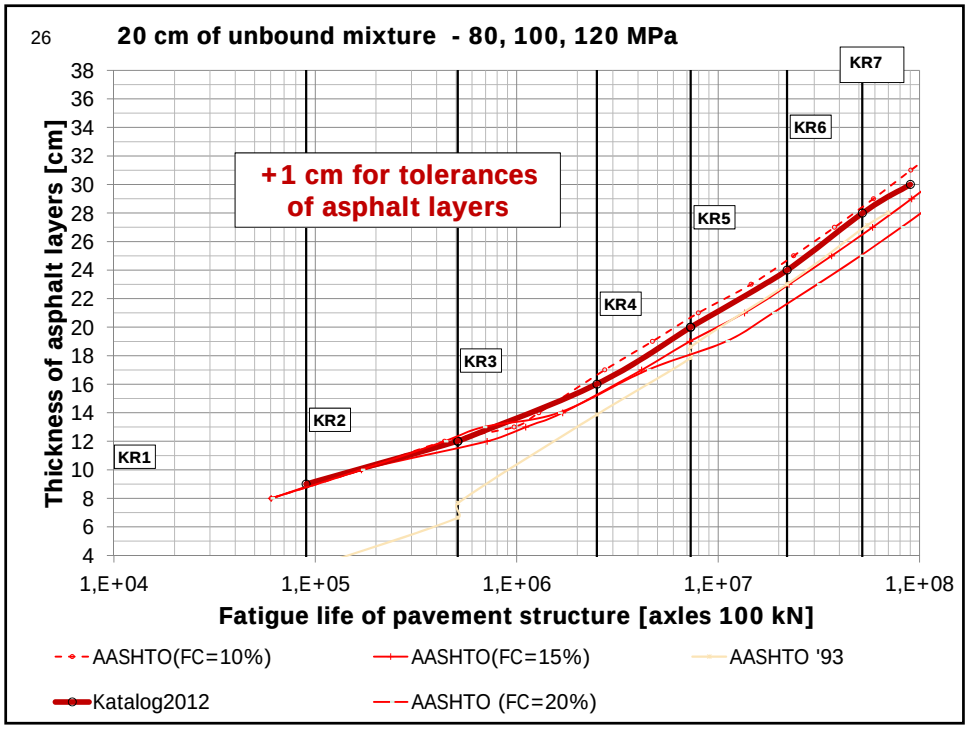
- Wheel load - 850 kPa, 50 kN (650 kPa, 50 kN)
- Stiffness of asphalt layers
  - Bitumen: 35/50 i 50/70 - D50/70
  - New volumetric proportion
  - New equivalent temperature
    - +13°C (+15°C) - +2, +10, +23°C

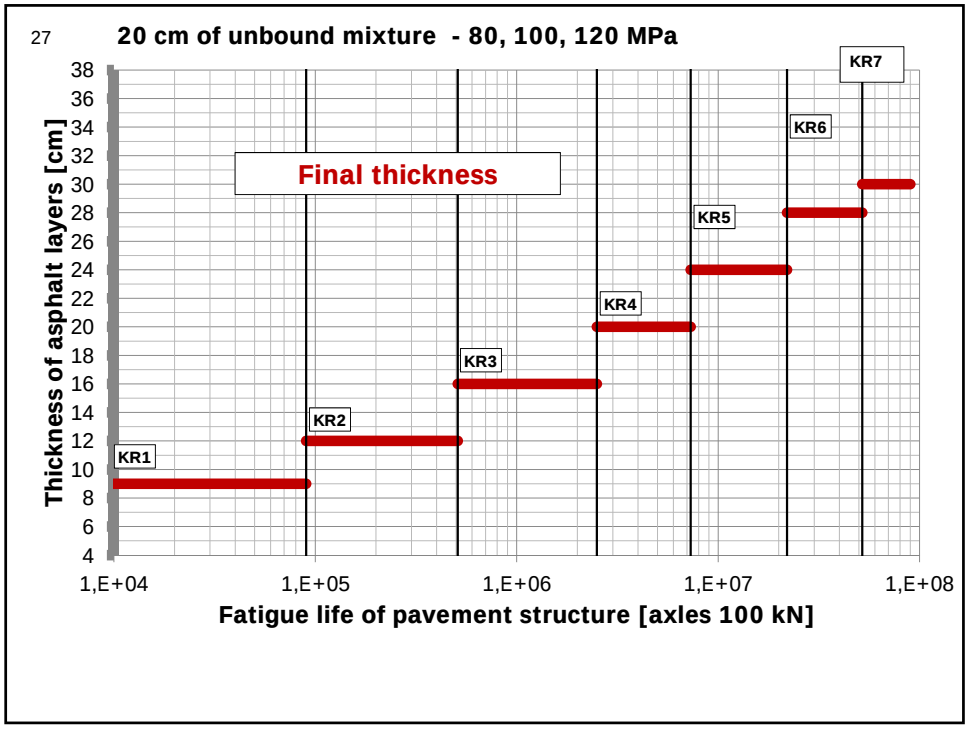
BASE COURSE

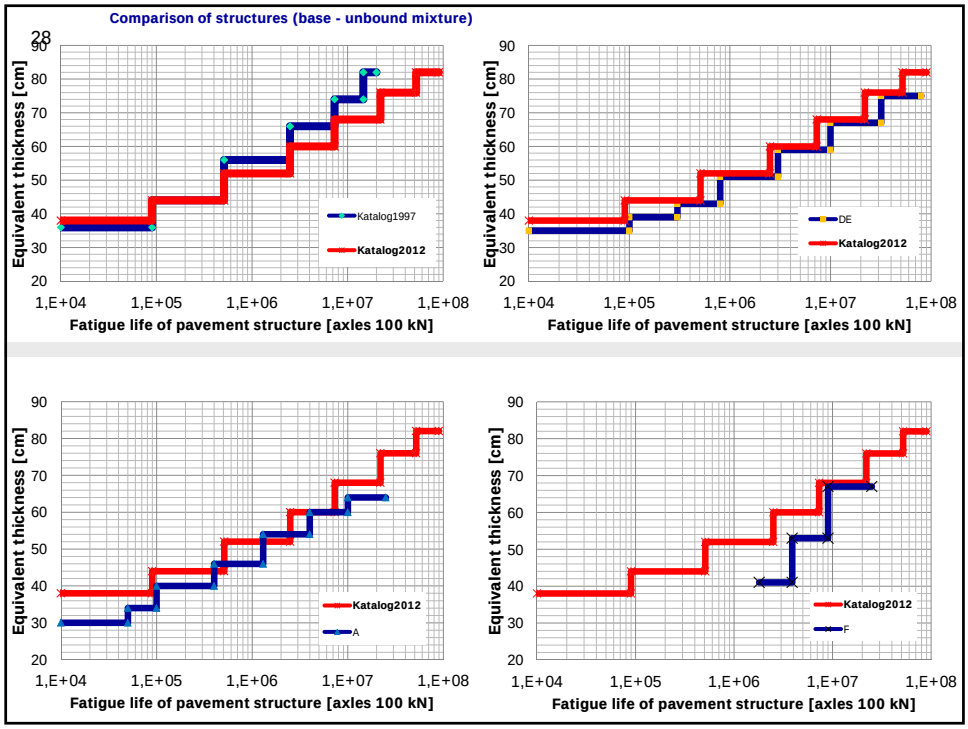
(UPPER) AC & (LOWER) UM



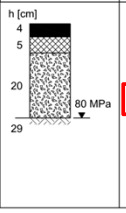
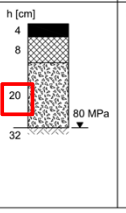
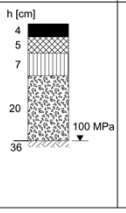
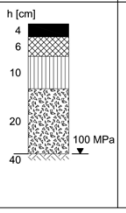
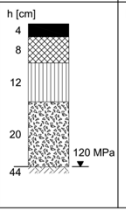
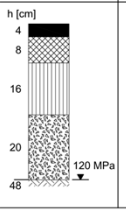
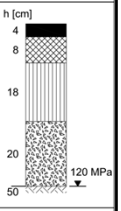

25
20 cm of unbound mixture - 80, 100, 120 MPa
Assumed curve H(N)
KR1
KR2
KR3
KR4
KR5
KR6
KR7
Thickness of asphalt layers [cm]
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
1,E+04
1,E+05
1,E+06
1,E+07
1,E+08
Fatigue life of pavement structure [axles 100 kN]
AASHTO(FC=10%)
AASHTO(FC=15%)
AASHTO '93
Katalog2012
AASHTO (FC=20%)


26
20 cm of unbound mixture - 80, 100, 120 MPa
+1 cm for tolerances of asphalt layers
KR1
KR2
KR3
KR4
KR5
KR6
KR7
Thickness of asphalt layers [cm]
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
1,E+04
1,E+05
1,E+06
1,E+07
1,E+08
Fatigue life of pavement structure [axles 100 kN]
AASHTO(FC=10%)
AASHTO(FC=15%)
AASHTO '93
Katalog2012
AASHTO (FC=20%)


27
20 cm of unbound mixture - 80, 100, 120 MPa
Final thickness
KR1
KR2
KR3
KR4
KR5
KR6
KR7
Thickness of asphalt layers [cm]
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
1,E+04
1,E+05
1,E+06
1,E+07
1,E+08
Fatigue life of pavement structure [axles 100 kN]


Comparison of structures (base - unbound mixture)
28
Equivalent thickness [cm]
Katalog1997
Katalog2012
DE
A
F
1,E+04
1,E+05
1,E+06
1,E+07
1,E+08
Fatigue life of pavement structure [axles 100 kN]

TYP A1: (upper base) - AC, (lower base) – unbound mixture $C_{90/3}$

Kategoria ruchu	KR1	KR2	KR3	KR4	KR5	KR6	KR7
Ruch projektowy (mln osi 100 kN)	0,03 - 0,09	0,09 - 0,5	0,5 - 2,5	2,5 - 7,4	7,4 - 22,0	22,0 - 52,0	> 52,0
TYP A1							

LEGENDA:

- warstwa ścieralna z mieszanki mineralno-asfaltowej, wymagania materiałowe wg punktu 7.12
- warstwa wiążąca z betonu asfaltowego wymagania materiałowe wg punktu 7.13
- warstwa podbudowy zasadniczej z betonu asfaltowego wykonana według punktu 10.12, wymagania materiałowe wg punktów 7.14 - 7.15
- warstwa podbudowy zasadniczej z mieszanki niezwiązanej $C_{90/3}$, wykonana wg punktu 10.12, materiały wg punktów 7.14 i 7.17
- wymagany wtórny moduł odkształcenia E_2

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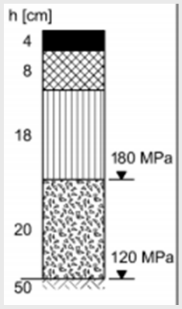
RESULTS – NEW STRUCTURES

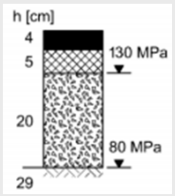
- Type A1 – **AC + UM $C_{90/3}$ – KR1-7**
- Type A2 – **AC + UM $C_{50/30}$ – KR1-7**
- Type A3 – **AC + UM C_{NR} – KR1-2**
- Type B – **AC (full depth) – KR1-7**
- Type C – **AC+HBM $C_{8/10}$, $C_{5/3}$, $C_{3/4}$ – KR1-7**
- Type D – **HTS $C_{1,5/2}$ – KR1-2**
- Type E – **CRM – KR1-4**

STRUCTURE EXAMPLES

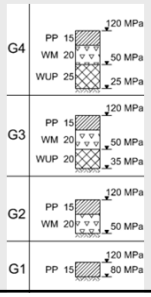
KR7 – 52-90 mln 100 kN KR1- 0,03-0,09 mln 100 kN

Upper layers -





Lower layers and improved subgrade -

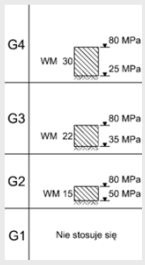


Very weak subgrade (E2>25 MPa or 2<CBR<3%)

Weak subgrade (E2>35 MPa or 3<CBR<5%)

Quite good subgrade (E2>50 MPa or 5<CBR<10%)

Strong subgrade (E2>80 MPa or CBR>10%)



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CONCLUSIONS

- New Polish Catalogue covers:
  - new extended traffic loads and design life period, EU standard materials (HBM) and recycling
- Safety margins:
  - traffic calculation, mechanical properties of materials (conservative), tollerances of asphalt layers
- It was implemented to official use by government in 2015

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THANK YOU - AITÄH

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